# Exhibit 1

## Touchdown Dynamics Testbed Project Overview and Testbed Objectives

# Motion Requirements

**Travel**
**X 5 m (16.5 ft)**
**Y 5 m (16.5 ft)**
**Z 5 m (16.5 ft)**

**Speed**
**X 1 m/s**
**Y 1 m/s**
**Z 2 m/s**

**Accel**
**X,Y,Z 1g**

**Payload**
**750 Kg (1650 lbs)**

**Confluence Point 150 kg (330 lbs)**
**Rover 600 kg (1320 lbs)**

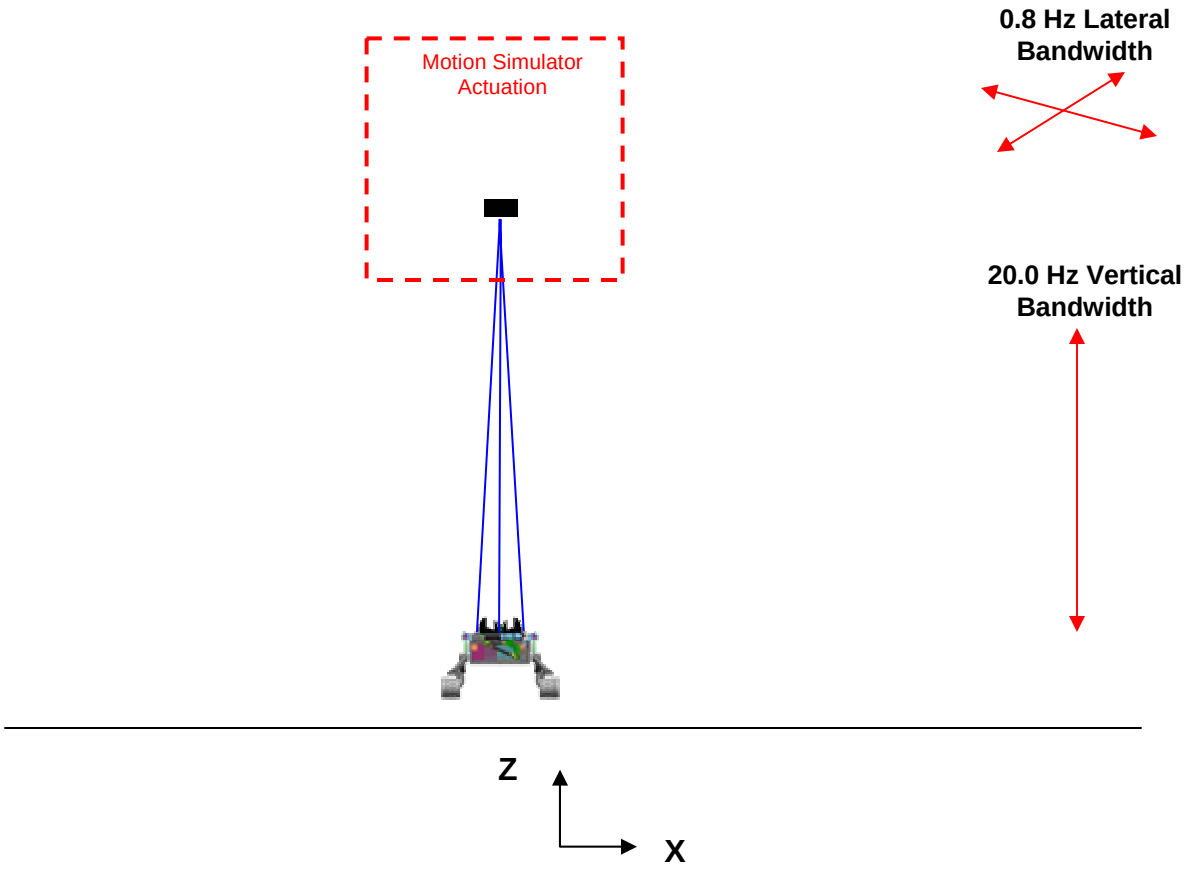



Figure 1

# Control System Block Diagram

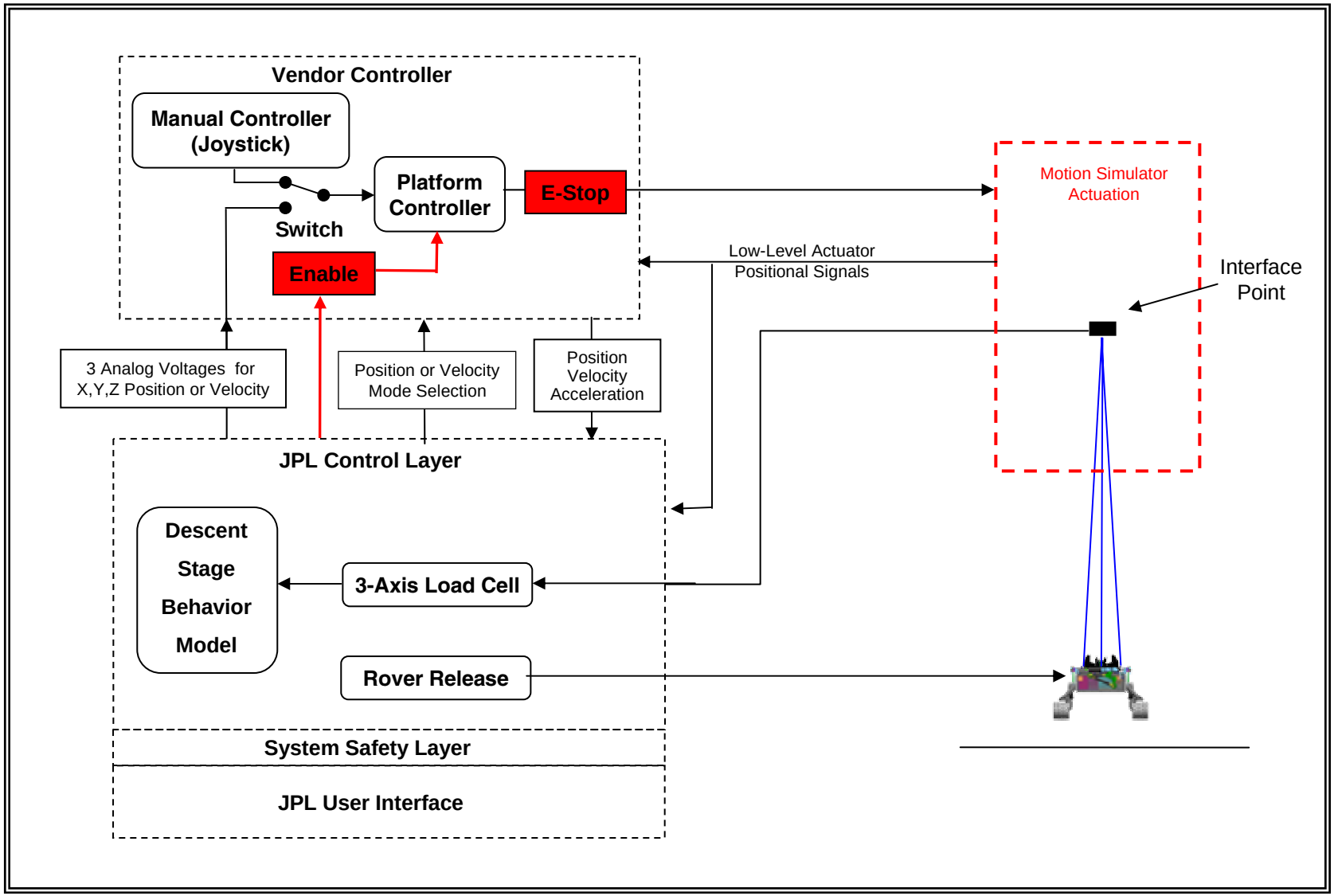



Figure 2

# Example Mode of Operation

- Use the vendor controller to position the interface point (location of the load cell/confluence point) down to the lowest Z station to allow hardware installation and modification.

- Use the JPL controller's user interface to input all specific test parameters:
  - Test article physical characteristics such as bridle length and rover mass
  - Desired (stable/damped) velocity vector at a desired intercept point
    - This will typically be ~.5 to 1 m above the desired impact point of the platform and will be user selected based on the specific platform and terrain configuration.
- On Command: The JPL controller will bring the system to a pre-determined starting point.
  - This will be an automatically calculated starting point which will have accounted for sufficient startup travel to damp out startup pendulum transients.
- On Command: The JPL controller will start the test and accelerate the test article to the desired speed at the predetermined intercept point.
  - The JPL control layer will provide force-feedback control to give the XYZ DOFs a specific compliance about their nominal motion.
  - All relevant performance data will be saved for post test analysis
- Automatically: the JPL control electronics will detect touchdown and send a command to release the bridles supporting the rover to reverse the nominal motion of the descent stage to allow it to follow a prescribed vertical trajectory.
- End of test.

Figure 3

# Example Mode of Operation – Flow Diagram

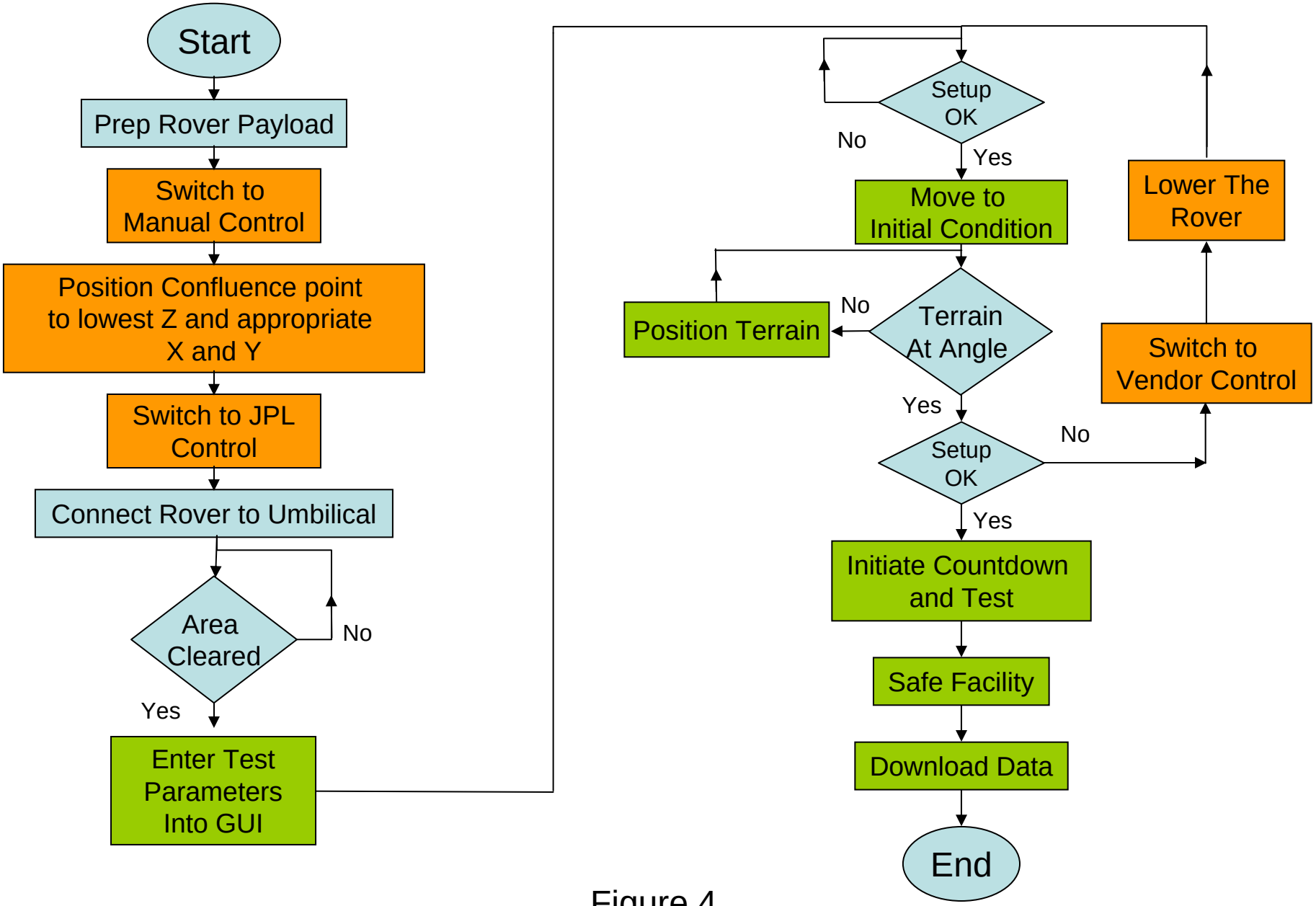
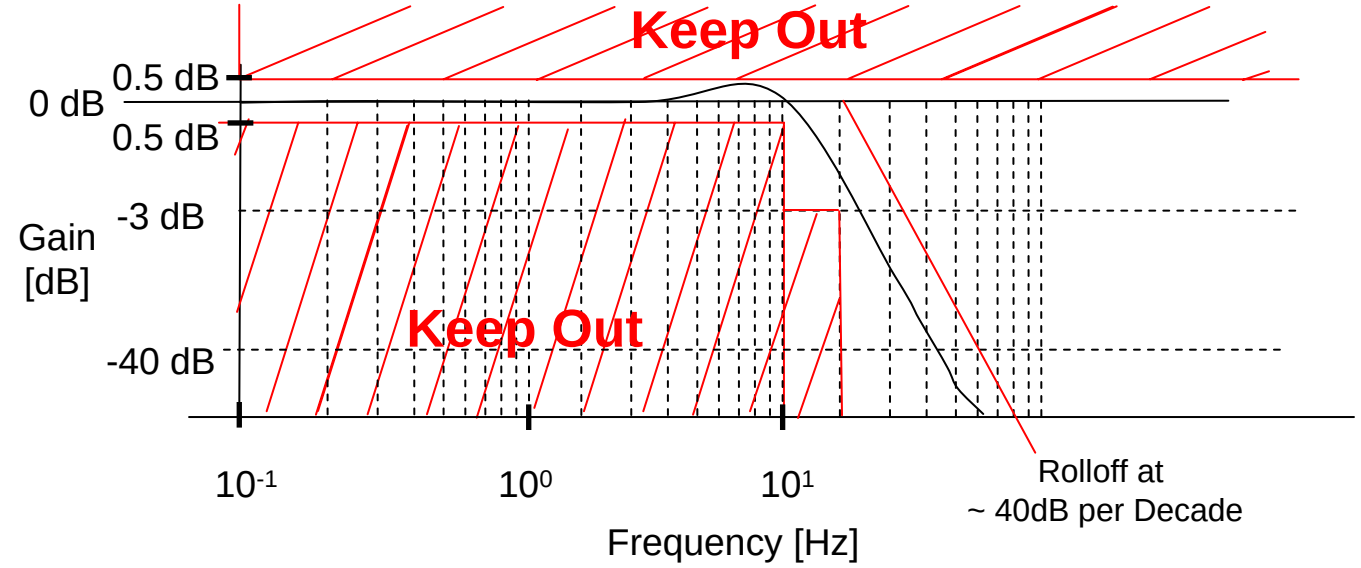



Figure 4

# Closed Loop Transfer Function Response



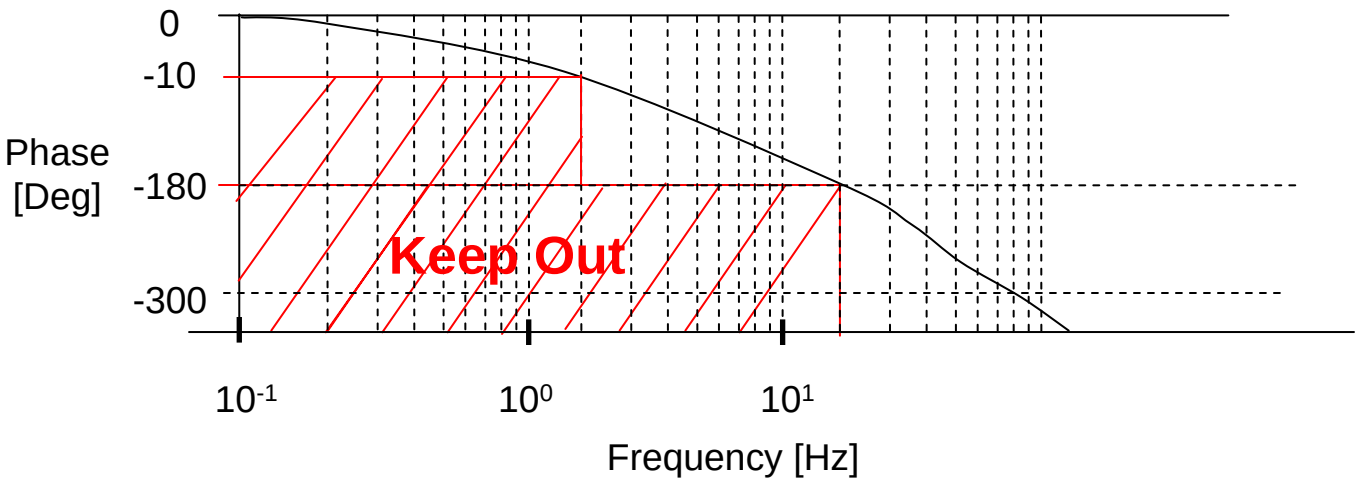




Figure 5

# Touchdown Dynamics Testbed Equipment

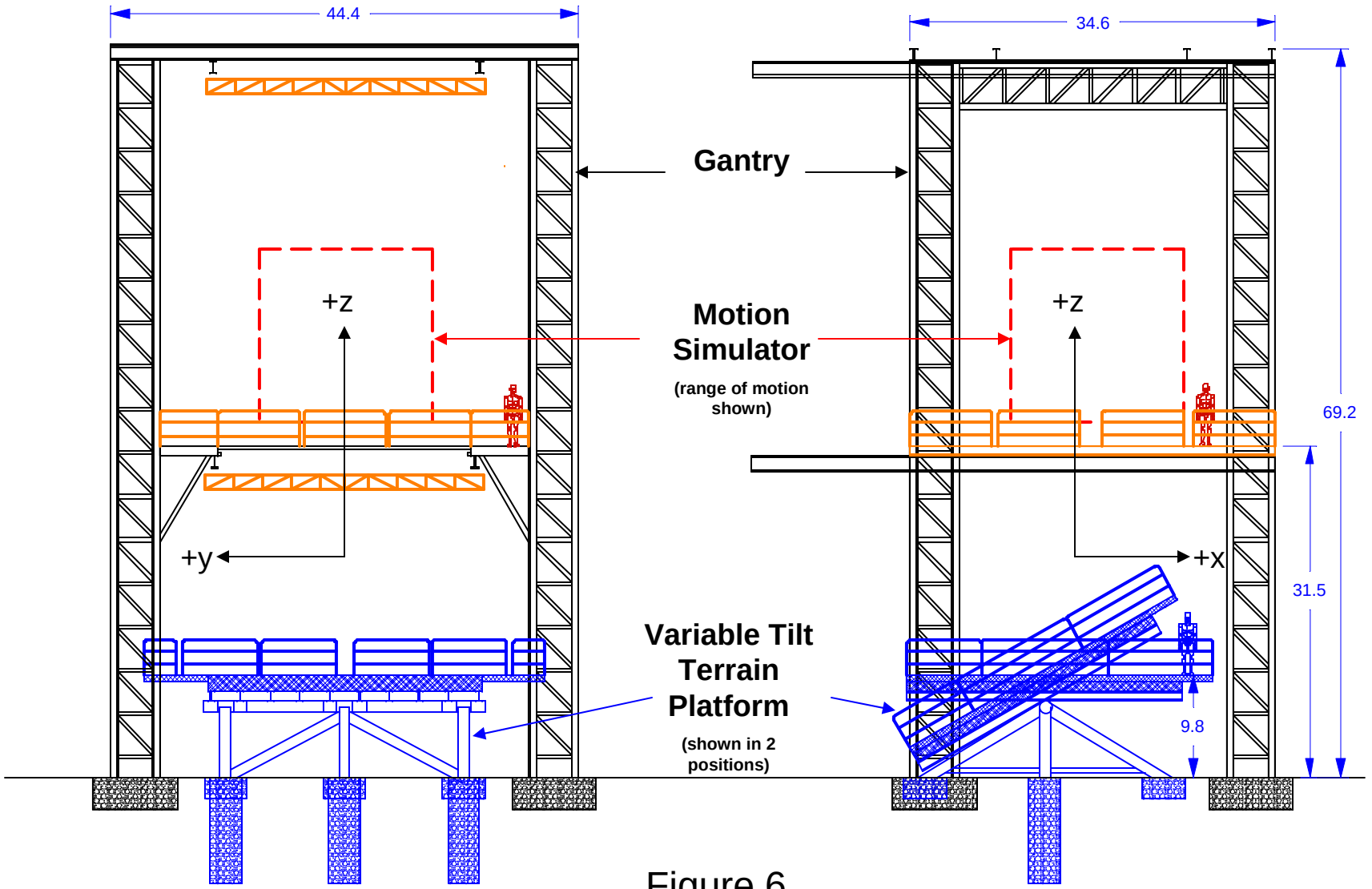



Figure 6

# Variable Tilt Terrain Platform

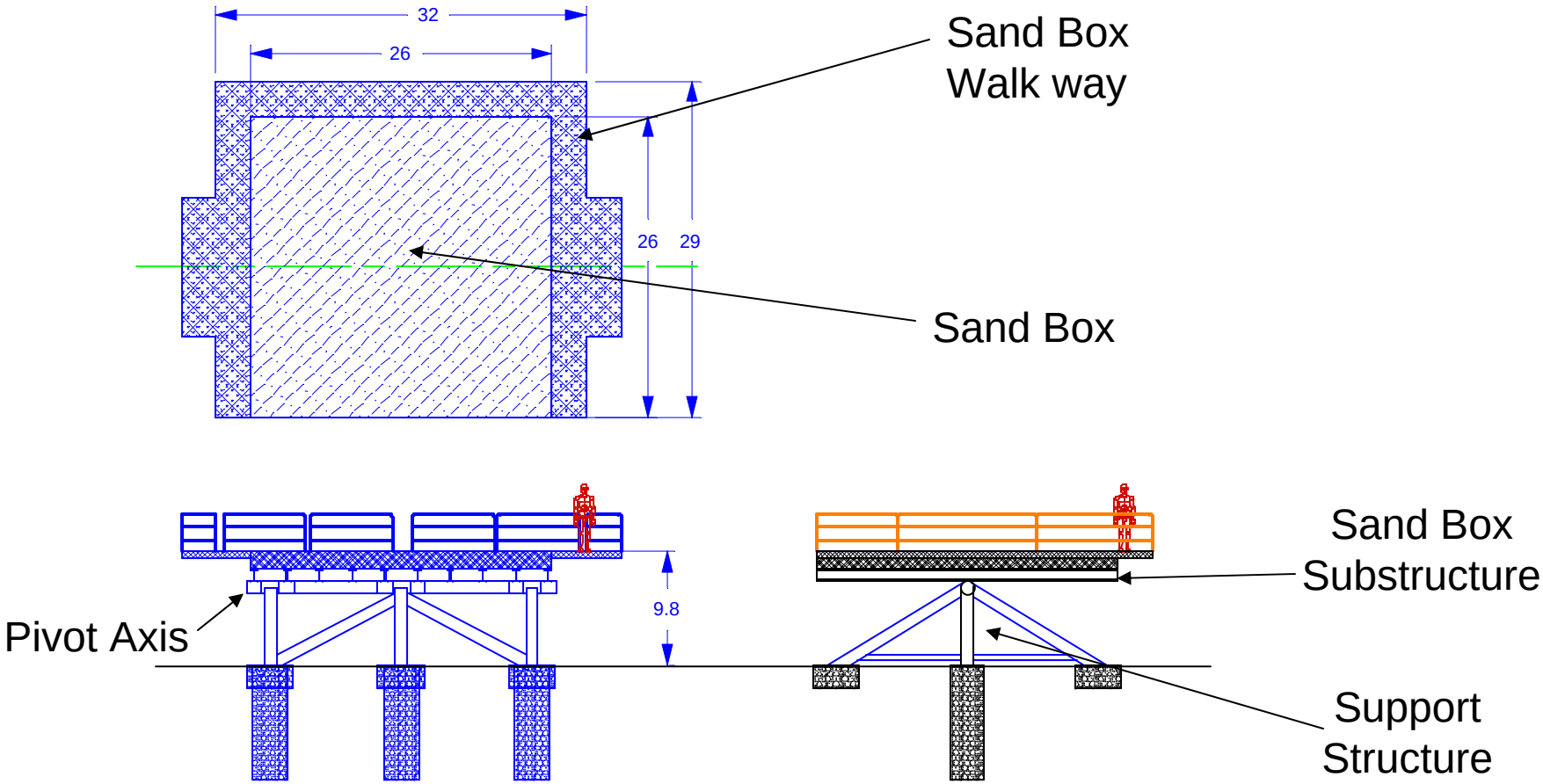



Figure 7

# Proposed JPL Provided Gantry

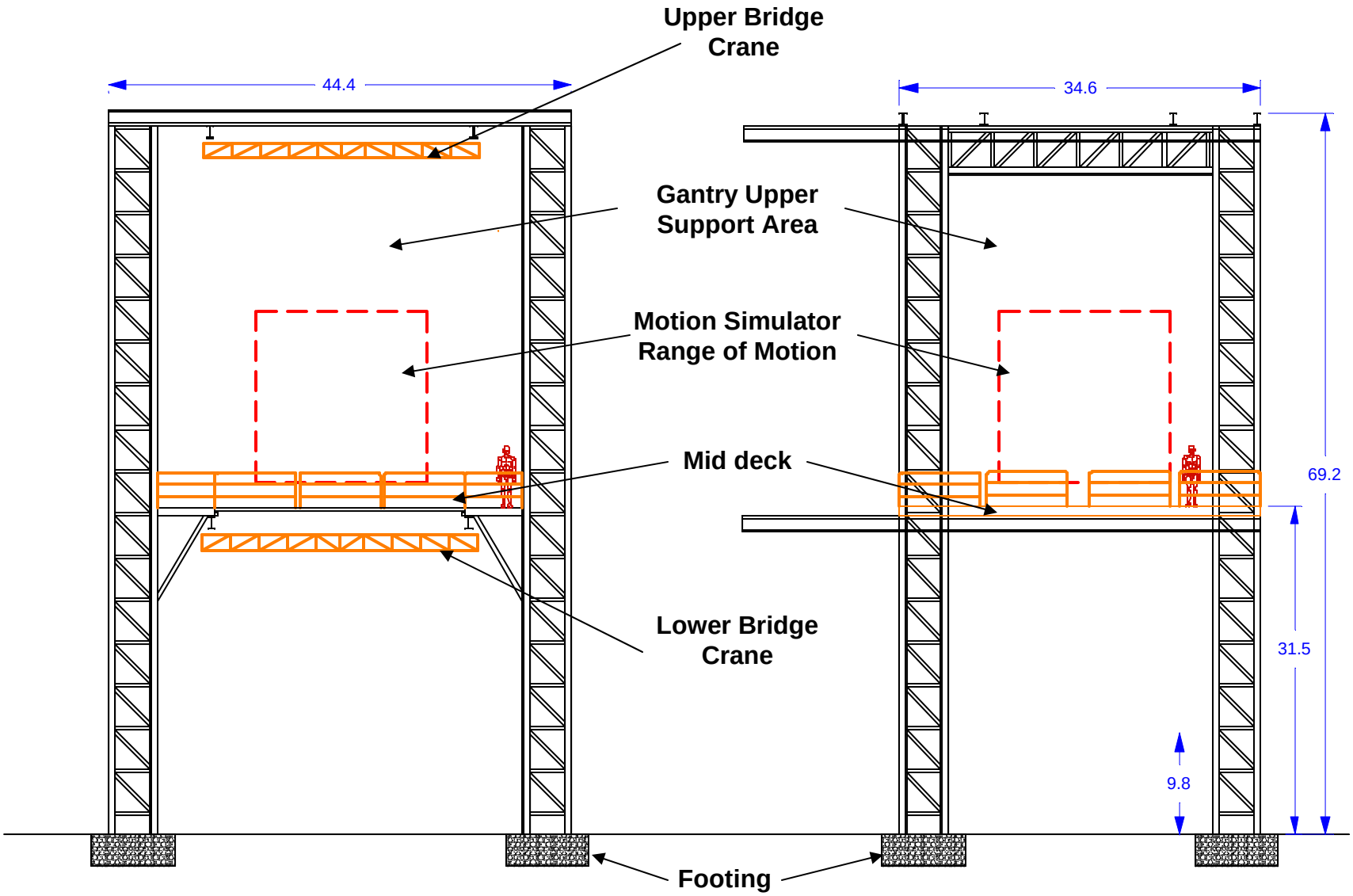



Figure 8

# Mid Deck Layout

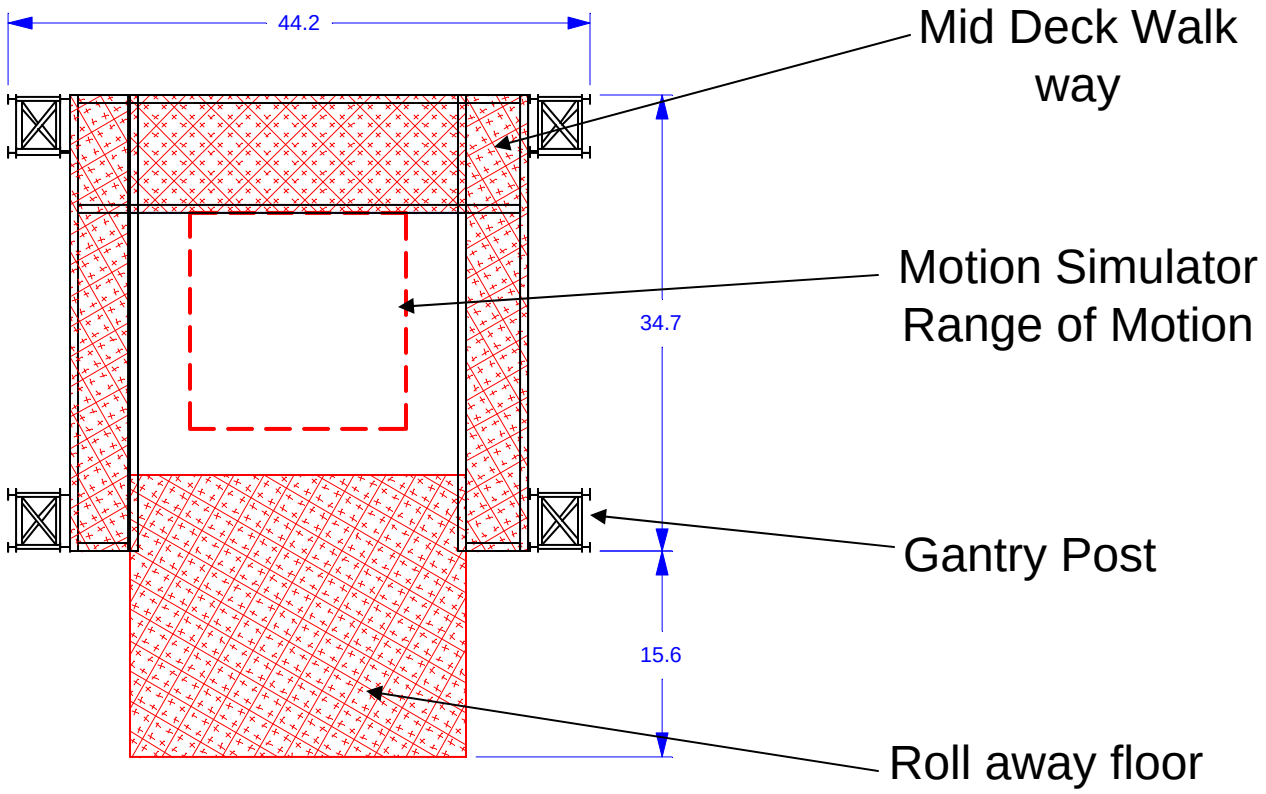



Figure 9

# Gantry Column Detail

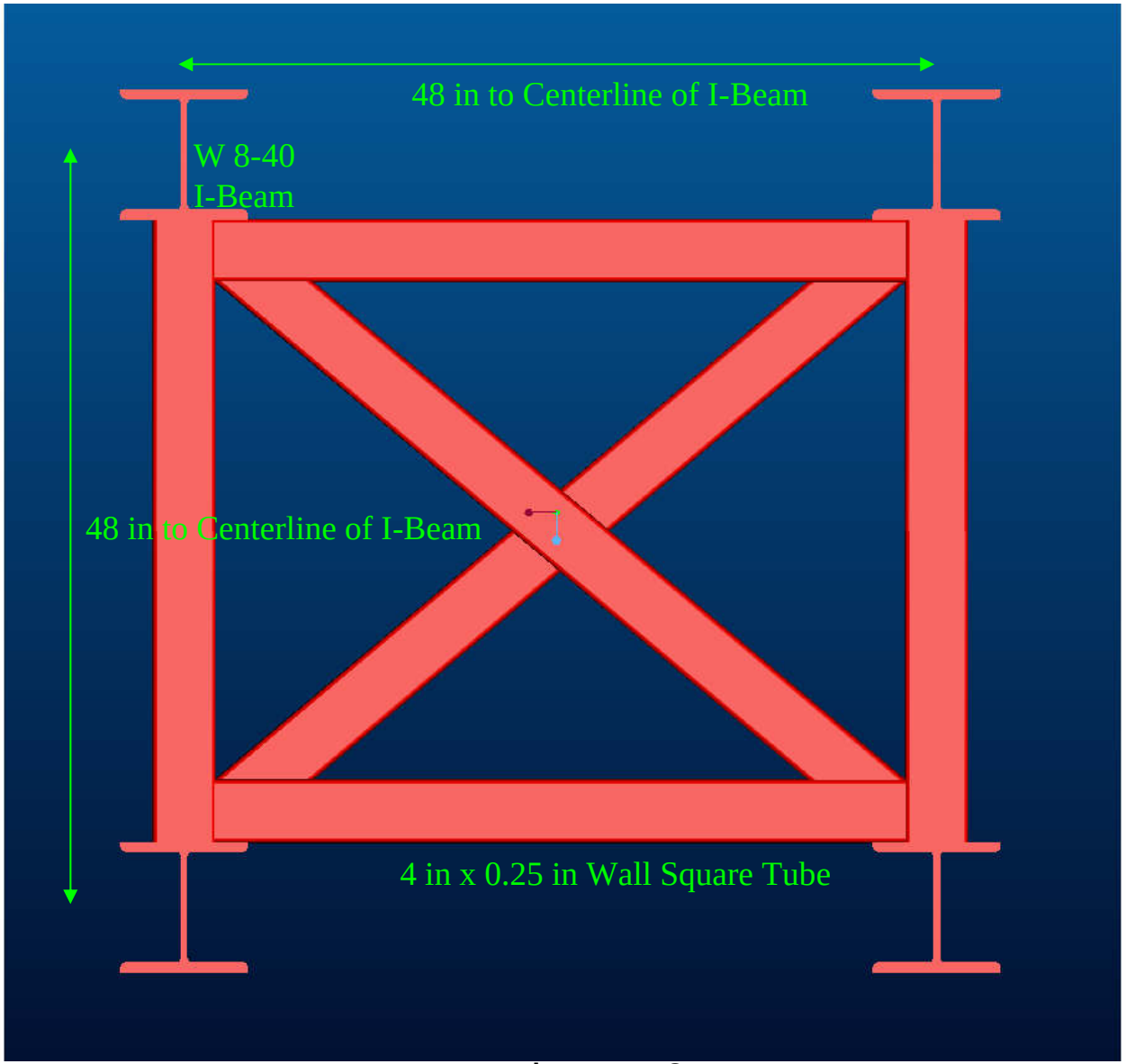



Figure 10

# Pre-Existing Structural Beams

Figure 11